<u>Side-Channel Inlet</u>. (See ES-85, page 2.114, for nomenclature.) Side-channel inlets are used only in those sites which require that the spillway be placed adjacent to or in a steep bank. The hydraulic theory of the side-channel inlet was first given by Julian Hinds.[1]

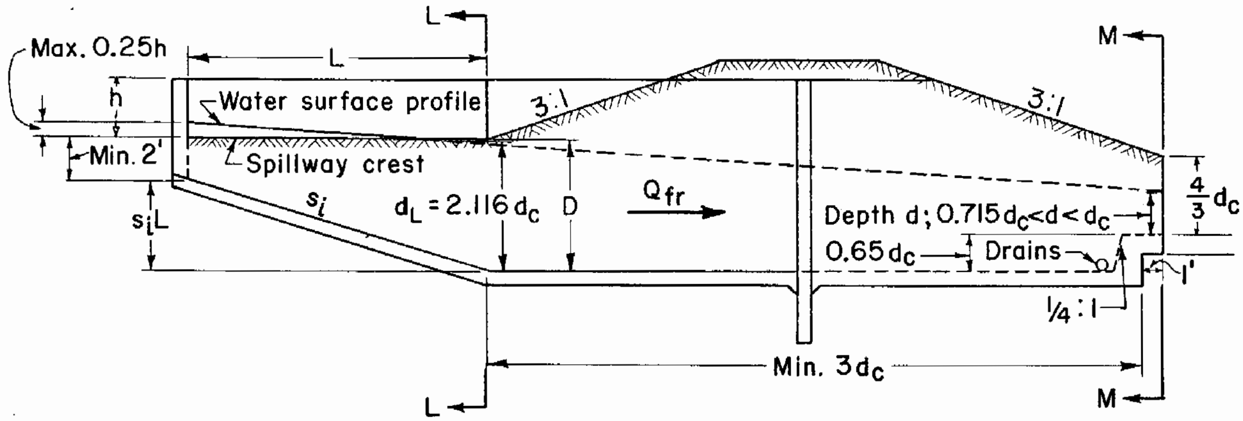



FIGURE 6

Arbitrarily designating the shape of the side-channel inlet to be rectangular removes the shape factor, which is generally decided by economic considerations. When the structure has small dimensions, the cost of a trapezoidal inlet is undoubtedly more than the simpler rectangular inlet, even though the rectangular inlet requires more concrete. Only a side-channel inlet having a rectangular shape is considered here.

The flow over the crest of a side-channel spillway is in a direction perpendicular to the axis of the inlet. (See Fig. 6.) The flow through the sections immediately below section L is very turbulent. The flow at section M will have acceptable velocity and discharge distribution if:[2]

a. A cross weir having a height of 0.65 $d_c$ is placed at section M.
b. The prismatic channel has a level floor and a length of 3 $d_c$ from section L to the cross weir.

The quantity $d_c$ is that critical depth corresponding to the required capacity $Q_{fr}$ at section M.

The depth of flow in the prismatic channel at section L can be determined by assuming the head losses due to friction and turbulence between section L and M. This depth is

$$d_L = 2.116\ d_c$$

[1]Side Channel Spillways, Trans. ASCE, Vol. 89, p. 881, 1926.

[2]From a composite study of existing model studies of side-channel spillways. Example; See Diversion, Outlet, and Spillway Structures; Boulder Canyon Project; Final Reports; Part IV; U. S. Bureau of Reclamation.

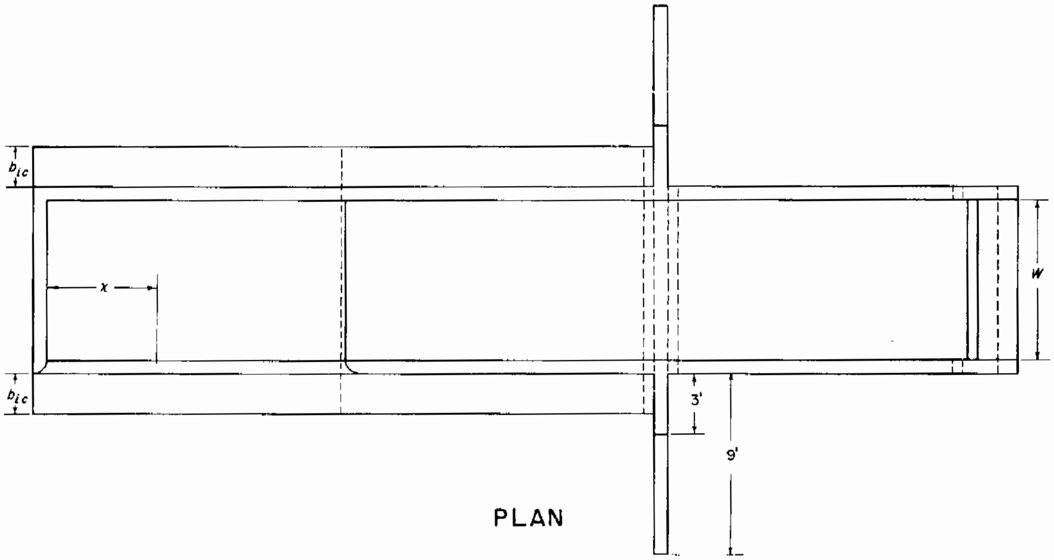
Capacity. The capacity without freeboard of a side-channel inlet is given by the weir formula:

$$Q_{mi} = 3.1\ L\ h^{3/2}$$

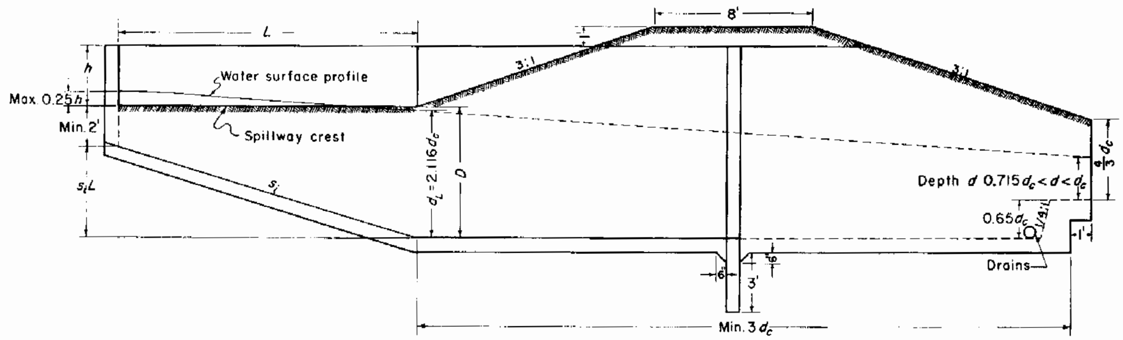
where $Q_{mi}$ = capacity without freeboard in cfs
$L$ = length of spillway crest in ft
$h$ = height of sidewalls above the spillway crest in ft

The coefficient 3.1 is believed to be conservative and its use is based on the assumption that the crest at the endwall is not submerged by more than 0.25 h. The water-surface profile upstream from section L is given by ES-85, page 2.114. This profile is required to determine that depth of the inlet D to prevent a submergence of greater than 0.25 h at the endwall.

# CHUTE SPILLWAYS: SIDE-CHANNEL INLETS; Layout

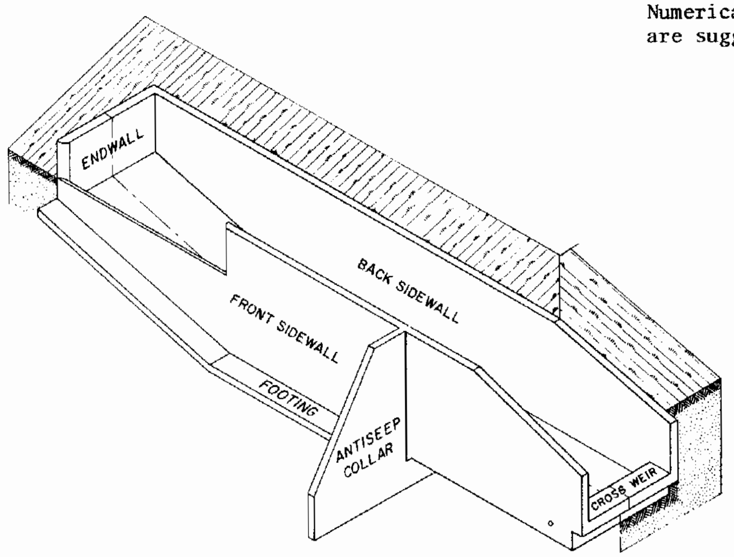



PLAN




SIDE ELEVATION

Numerical values shown are suggested minimums.




ISOMETRIC VIEW

| REFERENCE | U. S. DEPARTMENT OF AGRICULTURE<br>SOIL CONSERVATION SERVICE<br>ENGINEERING DIVISION-DESIGN SECTION | STANDARD DWG. NO.<br>ES-85<br>SHEET 1 OF 3<br>DATE MAY 1954 |
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Revised 10/77

# CHUTE SPILLWAYS : SIDE-CHANNEL INLETS ; Definitions, Formulas, Charts

## DEFINITION OF SYMBOLS

$h$ = Height of sidewalls over crest in ft
$M$ = Height of sidewalls above cross weir at origin of upper vertical curve in ft
$W$ = Width of chute in ft
$L$ = Length of inlet crest in ft
$D$ = Height of inlet crest above floor of basin in ft
$d$ = Depth of flow in ft
$d_c$ = Critical depth corresponding to capacity without freeboard of inlet in inlet basin $Q_{mi}$ in ft
$d_L$ = Depth of flow at section L of discharge $Q_{mi}$ in ft
$x$ = Distance from endwall measured along inlet crest in ft
$e$ = Elevation of water surface in basin measured above level portion of basin floor in ft
$s_i$ = Slope of basin floor from x = 0 to x = L in ft/ft
$b_{ii}$ = Width of footing in ft
$Q_r$ = Design discharge in cfs
$Q_{fr}$ = Capacity without freeboard in cfs
$Q_{si}$ = Capacity of vertical curve section with the recommended freeboard in cfs

## FORMULAS

$$Q = 3.1\, LH^{3/2}$$

$$\frac{d\left(\frac{d}{d_L}\right)}{d\left(\frac{x}{L}\right)} = \frac{K^3 - 2m\,\frac{x}{L}\,\frac{d}{d_L}}{\left(\frac{d}{d_L}\right)^3 - m\left(\frac{x}{L}\right)^2}\ ; \quad \text{where } m = \frac{d_c{}^3}{d_L{}^3} \text{ and } K = \frac{Ls_i}{d_L}$$

## CHARTS

CHART 1.

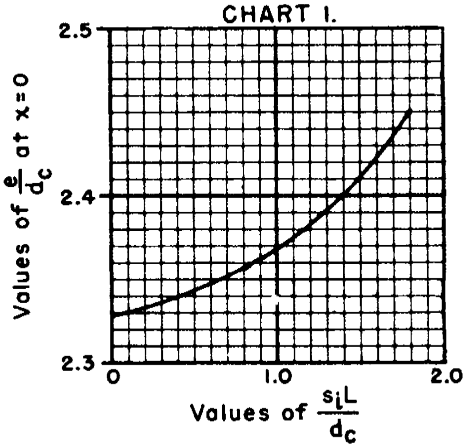
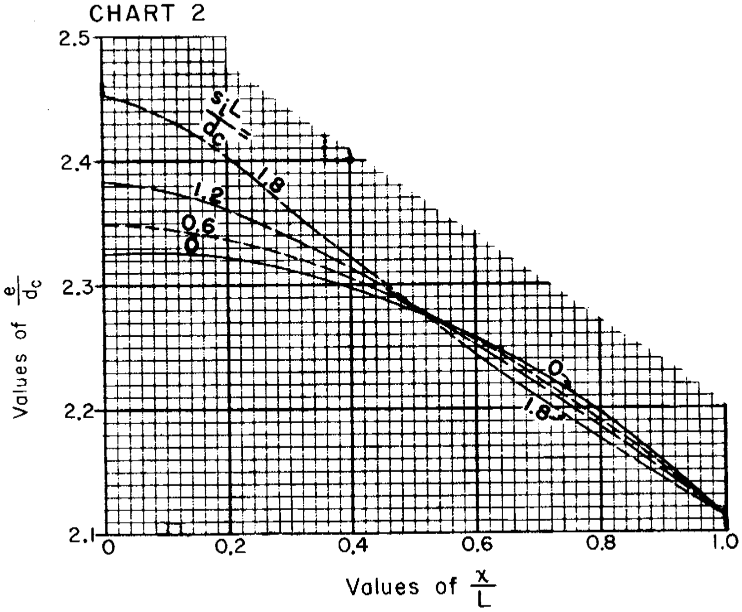



CHART 2




| REFERENCE | U. S. DEPARTMENT OF AGRICULTURE<br>SOIL CONSERVATION SERVICE<br>ENGINEERING DIVISION-DESIGN SECTION | STANDARD DWG. NO.<br>ES-85<br>SHEET 2 OF 3<br>DATE MAY 1954 |
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# CHUTE SPILLWAYS: SIDE-CHANNEL INLETS; Example

Given: A chute 8 ft wide having a total drop from crest of side-channel inlet to floor of outlet of Z = 30 ft and a design discharge of $Q_r$ = 180 cfs. The height of sidewalls h above the crest is 3 ft. No waves are anticipated.

Determine: 1. Required capacity of inlet without freeboard $Q_{fr}$.
2. Dimensions of side-channel inlet with the recommended freeboard using hydraulic criteria.
3. Approximate water-surface profile in the basin.

Solution: 1. $Q_{fr} = (1.20 + 0.003\ Z)Q_r$

$$= [(1.20 + (0.003)(30)] \, 180 = 232.2 \text{ cfs}$$

2. The value of critical depth $d_c$ for the discharge 232.2 cfs is, from ES-24,

$$q_{fr} = \frac{232.2}{8} = 29.03 \ ; \ d_c = 2.975 \text{ ft}$$

(a) The required length L of inlet crest having the recommended freeboard is

$$Q_{fr} = 3.1 \ Lh^{3/2}$$

$$L = \frac{232.2}{3.1(3)^{3/2}} = 14.4 \ ; \quad \text{take } L = 15 \text{ ft}$$

(b) Value of $M = \frac{4}{3} d_c$

$$M = \frac{4}{3} d_c = \frac{4}{3} \times 2.975 = 3.97 \text{ ft} \ ; \quad \text{take } M = 4 \text{ ft}$$

(c) Height of cross weir = $0.65\ d_c$

$$0.65\ d_c = 0.65(2.975) = 1.93 \text{ ft}$$

take height of cross weir = 2.00 ft

(d) The value of D is dependent, in part, on the value of $s_i$. Assume $s_iL/d_c = 1.5$, then the lower elevation of the water surface at x = 0; see chart 1 is 2.41 $d_c$ or

$$e = 2.41 \times 2.975 = 7.17 \text{ ft} \ ; \quad \text{take } e = 7.25 \text{ ft}$$

$$s_iL = 1.5 \times 2.975 = 4.46 \text{ ft} \ ; \quad \text{take } s_iL = 4.50 \text{ ft}$$

Since the maximum submergence at x = 0 is h/4 = 0.75 ft, this will make

$$D = e - \frac{h}{4} = 7.25 - 0.75 = 6.50 \text{ ft}$$

and

$$D - s_iL = 6.50 - 4.50 = 2.0 \text{ ft min.}$$

3. From chart 2 and interpolating for the line $s_iL/d_c = 1.5$ between the the given lines $s_iL/d_c = 1.2$ and 1.8, the approximate water surface profile is readily defined.